

# TC74VCX245FT

## 1. Functional Description

- Low-Voltage Octal Bus Transceiver with 3.6-V Tolerant Inputs and Outputs

## 2. General

The TC74VCX245FT is a high performance CMOS octal bus transceiver which is guaranteed to operate from 1.2 V to 3.6 V. Designed for use in 1.5 V, 1.8 V, 2.5 V or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

The direction of data transmission is determined by the level of the DIR inputs. The  $\overline{OE}$  inputs can be used to disable the device so that the busses are effectively isolated.

All inputs are equipped with protection circuits against static discharge.

## 3. Features (Note)

- (1) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C (Note 1)
- (2) Low-voltage operation:  $V_{CC} = 1.2$  to  $3.6$  V
- (3) High-speed operation:  $t_{pd} = 3.5$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)  
 $t_{pd} = 4.2$  ns (max) ( $V_{CC} = 2.3$  to  $2.7$  V)  
 $t_{pd} = 8.4$  ns (max) ( $V_{CC} = 1.65$  to  $1.95$  V)  
 $t_{pd} = 16.8$  ns (max) ( $V_{CC} = 1.4$  to  $1.6$  V)  
 $t_{pd} = 42.0$  ns (max) ( $V_{CC} = 1.2$  V)
- (4) Output current:  $I_{OH}/I_{OL} = \pm 24$  mA (min) ( $V_{CC} = 3.0$  V)  
 $I_{OH}/I_{OL} = \pm 18$  mA (min) ( $V_{CC} = 2.3$  V)  
 $I_{OH}/I_{OL} = \pm 6$  mA (min) ( $V_{CC} = 1.65$  V)  
 $I_{OH}/I_{OL} = \pm 2$  mA (min) ( $V_{CC} = 1.4$  V)
- (5) Latch-up performance:  $-300$  mA
- (6) ESD performance: Human Body Model  $\geq \pm 2000$  V
- (7) Bidirectional interface between 2.5 V and 3.3 V signals
- (8) 3.6 V tolerant function and power-down protection provided on all inputs and outputs.

Note: Do not apply a signal to any bus pins when it is in the output mode. Damage may result.

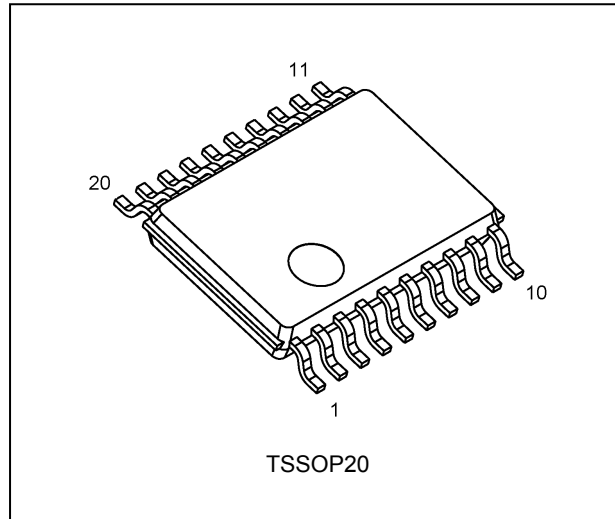
All floating (high impedance) bus pins must have their input levels fixed by means of pull-up or pull-down resistors.

Note 1: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after April 2020.

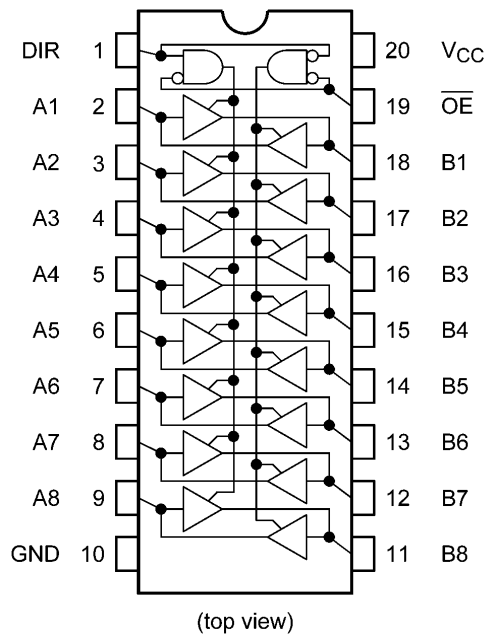
Start of commercial production

2020-04

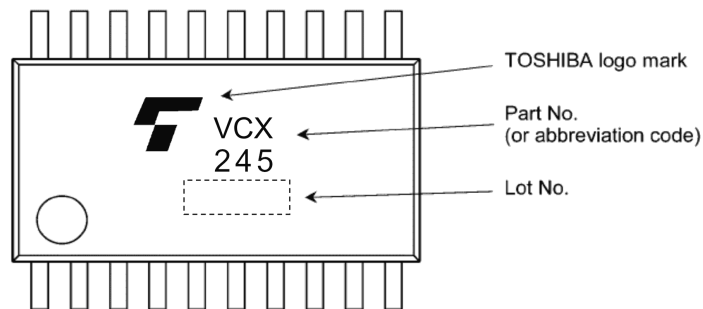
## 4. Packaging



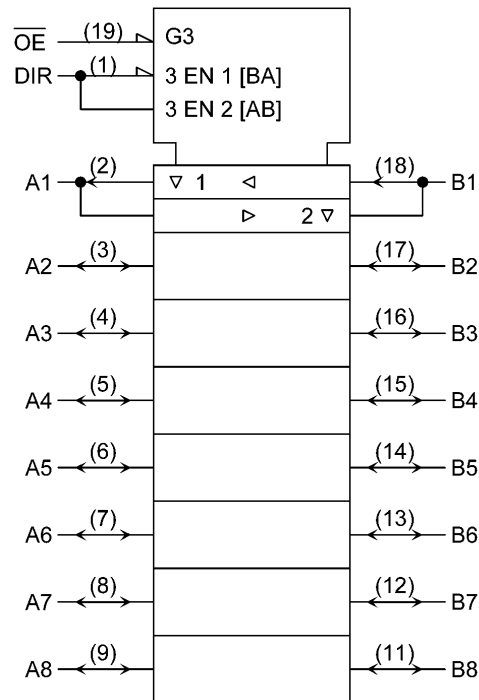
## 5. Pin Assignment



## 6. Marking



## 7. IEC Logic Symbol



## 8. Truth Table

Input $\overline{OE}$	Input DIR	Outputs	Function A-Bus	Function B-Bus
L	L	A = B	Output	Input
L	H	B = A	Input	Output
H	X	Z	Z	Z

X: Don't care  
Z: High impedance

### 9. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		-0.5 to 4.6	V
Input voltage(DIR/OE)	$V_{IN}$		-0.5 to 4.6	V
Bus I/O voltage	$V_{I/O}$	(Note 1)	-0.5 to 4.6	V
		(Note 2)	-0.5 to $V_{CC} + 0.5$	
Input diode current	$I_{IK}$		-50	mA
Output diode current	$I_{OK}$	(Note 3)	$\pm 50$	mA
Output current	$I_{OUT}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 4)	180	mW
$V_{CC}$ /ground current	$I_{CC}/I_{GND}$		$\pm 100$	mA
Storage temperature	$T_{stg}$		-65 to 150	$^{\circ}C$

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: Output in OFF state.

Note 2: High (H) or Low (L) state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 3:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

Note 4: 180 mW in the range of  $T_a = -40$  to  $85^{\circ}C$ . From  $T_a = 85$  to  $125^{\circ}C$  a derating factor of  $-3.25$  mW/ $^{\circ}C$  shall be applied until 50 mW.

### 10. Operating Ranges (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		1.2 to 3.6	V
Input voltage(DIR/OE)	$V_{IN}$		-0.3 to 3.6	V
Bus I/O voltage	$V_{I/O}$	(Note 1)	0 to 3.6	V
		(Note 2)	0 to $V_{CC}$	
Output current	$I_{OH}, I_{OL}$	(Note 3)	$\pm 24$	mA
		(Note 4)	$\pm 18$	
		(Note 5)	$\pm 6$	
		(Note 6)	$\pm 2$	
Operating temperature	$T_{opr}$	(Note 7)	-40 to 125	$^{\circ}C$
Input rise and fall times	$dt/dv$	(Note 8)	0 to 10	ns/V

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs and bus inputs must be tied to either  $V_{CC}$  or GND. Please connect both bus inputs and the bus outputs with  $V_{CC}$  or GND when the I/O of the bus terminal changes by the function. In this case, please note that the output is not short-circuited.

Note 1: Output in OFF state.

Note 2: High (H) or Low (L) state.

Note 3:  $V_{CC} = 3.0$  to  $3.6$  V

Note 4:  $V_{CC} = 2.3$  to  $2.7$  V

Note 5:  $V_{CC} = 1.65$  to  $1.95$  V

Note 6:  $V_{CC} = 1.4$  to  $1.6$  V

Note 7: Operating Range spec of  $T_{opr} = -40^{\circ}C$  to  $125^{\circ}C$  is applicable only for the products which manufactured after April 2020.

Note 8:  $V_{IN} = 0.8$  to  $2.0$  V,  $V_{CC} = 3.0$  V

### 11. Electrical Characteristics

#### 11.1. DC Characteristics (Unless otherwise specified, $T_a = -40$ to $85^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—	1.2 to 1.4	$V_{CC} \times 0.8$	—	V	
			1.4 to 1.65	$V_{CC} \times 0.65$	—		
			1.65 to 2.3	$V_{CC} \times 0.65$	—		
			2.3 to 2.7	1.6	—		
			2.7 to 3.6	2.0	—		
Low-level input voltage	$V_{IL}$	—	1.2 to 1.4	—	$V_{CC} \times 0.05$	V	
			1.4 to 1.65	—	$V_{CC} \times 0.05$		
			1.65 to 2.3	—	$V_{CC} \times 0.2$		
			2.3 to 2.7	—	0.7		
			2.7 to 3.6	—	0.8		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -100 \mu\text{A}$	1.2	$V_{CC} - 0.1$	—	V
				1.4 to 1.65	$V_{CC} - 0.2$	—	
				1.65 to 3.6	$V_{CC} - 0.2$	—	
			$I_{OH} = -2 \text{ mA}$	1.4	1.05	—	
				1.65	1.25	—	
			$I_{OH} = -6 \text{ mA}$	2.3	2.0	—	
				2.7	2.2	—	
			$I_{OH} = -12 \text{ mA}$	2.3	1.8	—	
				2.7	2.2	—	
			$I_{OH} = -18 \text{ mA}$	2.3	1.7	—	
3.0	2.4	—					
$I_{OH} = -24 \text{ mA}$	2.3	1.7	—				
	3.0	2.4	—				
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 100 \mu\text{A}$	1.2	—	0.05	V
				1.4 to 1.65	—	0.05	
				1.65 to 3.6	—	0.2	
			$I_{OL} = 2 \text{ mA}$	1.4	—	0.35	
				1.65	—	0.3	
			$I_{OL} = 6 \text{ mA}$	2.3	—	0.4	
				2.7	—	0.4	
			$I_{OL} = 12 \text{ mA}$	2.3	—	0.6	
				3.0	—	0.4	
			$I_{OL} = 18 \text{ mA}$	2.3	—	0.6	
3.0	—	0.4					
$I_{OL} = 24 \text{ mA}$	2.3	—	0.6				
	3.0	—	0.55				
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $3.6 \text{ V}$	1.2 to 3.6	—	$\pm 5.0$	$\mu\text{A}$	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $3.6 \text{ V}$	1.2 to 3.6	—	$\pm 10.0$	$\mu\text{A}$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN}/V_{OUT} = 0$ to $3.6 \text{ V}$	0	—	10.0	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or $\text{GND}$	1.2 to 3.6	—	20.0	$\mu\text{A}$	
		$V_{CC} \leq (V_{IN}/V_{OUT}) \leq 3.6 \text{ V}$	1.2 to 3.6	—	$\pm 20.0$		
	$\Delta I_{CC}$	$V_{IH} = V_{CC} - 0.6 \text{ V}$ (per input)	2.7 to 3.6	—	750	$\mu\text{A}$	

### 11.2. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125$ °C)

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—	1.2 to 1.4	$V_{CC} \times 0.8$	—	V	
			1.4 to 1.65	$V_{CC} \times 0.65$	—		
			1.65 to 2.3	$V_{CC} \times 0.65$	—		
			2.3 to 2.7	1.6	—		
			2.7 to 3.6	2.0	—		
Low-level input voltage	$V_{IL}$	—	1.2 to 1.4	—	$V_{CC} \times 0.05$	V	
			1.4 to 1.65	—	$V_{CC} \times 0.05$		
			1.65 to 2.3	—	$V_{CC} \times 0.2$		
			2.3 to 2.7	—	0.7		
			2.7 to 3.6	—	0.8		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -100 \mu A$	1.2	$V_{CC} - 0.1$	—	V
				1.4 to 1.65	$V_{CC} - 0.2$	—	
				1.65 to 3.6	$V_{CC} - 0.2$	—	
			$I_{OH} = -2 \text{ mA}$	1.4	1.05	—	
				1.65	1.25	—	
			$I_{OH} = -6 \text{ mA}$	2.3	2.0	—	
				2.7	2.2	—	
			$I_{OH} = -12 \text{ mA}$	2.3	1.8	—	
				3.0	2.4	—	
			$I_{OH} = -18 \text{ mA}$	2.3	1.6	—	
3.0	2.2	—					
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 100 \mu A$	1.2	—	0.05	V
				1.4 to 1.65	—	0.05	
				1.65 to 3.6	—	0.2	
			$I_{OL} = 2 \text{ mA}$	1.4	—	0.35	
				1.65	—	0.3	
			$I_{OL} = 6 \text{ mA}$	2.3	—	0.4	
				2.7	—	0.4	
			$I_{OL} = 12 \text{ mA}$	2.3	—	0.8	
				3.0	—	0.4	
			$I_{OL} = 18 \text{ mA}$	2.3	—	0.8	
3.0	—	0.4					
$I_{OL} = 24 \text{ mA}$	2.3	—	0.8				
	3.0	—	0.55				
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $3.6 \text{ V}$	1.2 to 3.6	—	$\pm 20.0$	$\mu A$	
3-state output OFF-state leakage current	$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $3.6 \text{ V}$	1.2 to 3.6	—	$\pm 40.0$	$\mu A$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN}/V_{OUT} = 0$ to $3.6 \text{ V}$	0	—	40.0	$\mu A$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	1.2 to 3.6	—	80.0	$\mu A$	
		$V_{CC} \leq (V_{IN}/V_{OUT}) \leq 3.6 \text{ V}$	1.2 to 3.6	—	$\pm 80.0$		
	$\Delta I_{CC}$	$V_{IH} = V_{CC} - 0.6 \text{ V}$ (per input)	2.7 to 3.6	—	1.5	mA	

Note: Operating Range spec of  $T_{opr} = -40$  °C to  $125$  °C is applicable only for the products which manufactured after April 2020.

### 11.3. AC Characteristics (Unless otherwise specified, $T_a = -40$ to $85^\circ\text{C}$ )

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		See 11.7 AC Test Circuit, Table 11.7.1, Fig. 11.8.1, Table 11.8.1	1.2	1.5	42.0	ns
				$1.5 \pm 0.1$	1.0	16.8	
				$1.8 \pm 0.15$	1.5	8.4	
				$2.5 \pm 0.2$	0.8	4.2	
				$3.3 \pm 0.3$	0.6	3.5	
3-state output enable time	$t_{PZL}, t_{PZH}$		See 11.7 AC Test Circuit, Table 11.7.1, Fig. 11.8.2, Table 11.8.1	1.2	1.5	49.0	ns
				$1.5 \pm 0.1$	1.0	19.6	
				$1.8 \pm 0.15$	1.5	9.8	
				$2.5 \pm 0.2$	0.8	5.6	
				$3.3 \pm 0.3$	0.6	4.5	
3-state output disable time	$t_{PLZ}, t_{PHZ}$		See 11.7 AC Test Circuit, Table 11.7.1, Fig. 11.8.2, Table 11.8.1	1.2	1.5	36.0	ns
				$1.5 \pm 0.1$	1.0	14.4	
				$1.8 \pm 0.15$	1.5	7.2	
				$2.5 \pm 0.2$	0.8	4.0	
				$3.3 \pm 0.3$	0.6	3.6	
Output skew	$t_{osLH}, t_{osHL}$	(Note 1)	—	1.2	—	1.5	ns
				$1.5 \pm 0.1$	—	1.5	
				$1.8 \pm 0.15$	—	0.5	
				$2.5 \pm 0.2$	—	0.5	
				$3.3 \pm 0.3$	—	0.5	

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{osHL} = |t_{PHLm} - t_{PHLn}|$ )

### 11.4. AC Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $125^\circ\text{C}$ )

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		See 11.7 AC Test Circuit, Table 11.7.1, Fig. 11.8.1, Table 11.8.1	1.2	1.5	55.0	ns
				$1.5 \pm 0.1$	1.0	21.4	
				$1.8 \pm 0.15$	1.5	10.0	
				$2.5 \pm 0.2$	0.8	5.0	
				$3.3 \pm 0.3$	0.6	4.2	
3-state output enable time	$t_{PZL}, t_{PZH}$		See 11.7 AC Test Circuit, Table 11.7.1, Fig. 11.8.2, Table 11.8.1	1.2	1.5	60.0	ns
				$1.5 \pm 0.1$	1.0	23.2	
				$1.8 \pm 0.15$	1.5	11.6	
				$2.5 \pm 0.2$	0.8	6.5	
				$3.3 \pm 0.3$	0.6	5.4	
3-state output disable time	$t_{PLZ}, t_{PHZ}$		See 11.7 AC Test Circuit, Table 11.7.1, Fig. 11.8.2, Table 11.8.1	1.2	1.5	45.0	ns
				$1.5 \pm 0.1$	1.0	17.9	
				$1.8 \pm 0.15$	1.5	9.0	
				$2.5 \pm 0.2$	0.8	5.0	
				$3.3 \pm 0.3$	0.6	4.5	
Output skew	$t_{osLH}, t_{osHL}$	(Note 1)	—	1.2	—	2.0	ns
				$1.5 \pm 0.1$	—	2.0	
				$1.8 \pm 0.15$	—	1.0	
				$2.5 \pm 0.2$	—	1.0	
				$3.3 \pm 0.3$	—	1.0	

Note: Operating Range spec of  $T_{opr} = -40^\circ\text{C}$  to  $125^\circ\text{C}$  is applicable only for the products which manufactured after April 2020.

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHm} - t_{PLHn}|$ ,  $t_{osHL} = |t_{PHLm} - t_{PHLn}|$ )

### 11.5. Dynamic Switching Characteristics (Note)

(Unless otherwise specified,  $T_a = 25^\circ\text{C}$ , Input:  $t_r = t_f = 2.0 \text{ ns}$ ,  $C_L = 30 \text{ pF}$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$V_{IH} = 1.8 \text{ V}, V_{IL} = 0 \text{ V}$	1.8	0.25	V
		$V_{IH} = 2.5 \text{ V}, V_{IL} = 0 \text{ V}$	2.5	0.6	
		$V_{IH} = 3.3 \text{ V}, V_{IL} = 0 \text{ V}$	3.3	0.8	
Quiet output minimum dynamic $V_{OL}$	$V_{OLV}$	$V_{IH} = 1.8 \text{ V}, V_{IL} = 0 \text{ V}$	1.8	-0.25	V
		$V_{IH} = 2.5 \text{ V}, V_{IL} = 0 \text{ V}$	2.5	-0.6	
		$V_{IH} = 3.3 \text{ V}, V_{IL} = 0 \text{ V}$	3.3	-0.8	
Quiet output minimum dynamic $V_{OH}$	$V_{OHV}$	$V_{IH} = 1.8 \text{ V}, V_{IL} = 0 \text{ V}$	1.8	1.5	V
		$V_{IH} = 2.5 \text{ V}, V_{IL} = 0 \text{ V}$	2.5	1.9	
		$V_{IH} = 3.3 \text{ V}, V_{IL} = 0 \text{ V}$	3.3	2.2	

Note: Parameter guaranteed by design.

### 11.6. Capacitive Characteristics (Unless otherwise specified, $T_a = 25^\circ\text{C}$ )

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Typ.	Unit
Input capacitance	$C_{IN}$		—	1.8, 2.5, 3.3	6	pF
Bus I/O capacitance	$C_{I/O}$		—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	$f_{IN} = 10 \text{ MHz}$	1.8, 2.5, 3.3	20	pF

Note 1:  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8 \text{ (per 1 gate)}$$

### 11.7. AC Test Circuit

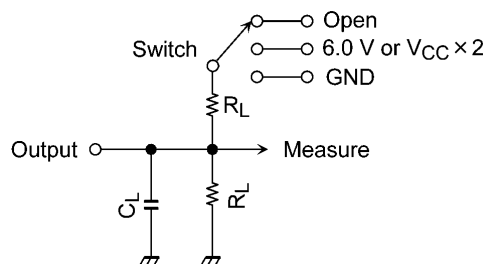


Table 11.7.1 Parameter for AC Test Circuit

Parameter	Switch	Test Condition
$t_{PLH}, t_{PHL}$	OPEN	—
$t_{PLZ}, t_{PZL}$	6.0 V	$V_{CC} = 3.3 \pm 0.3 \text{ V}$
	$V_{CC} \times 2$	$V_{CC} = 2.5 \pm 0.2 \text{ V}$
		$V_{CC} = 1.8 \pm 0.15 \text{ V}$
		$V_{CC} = 1.5 \pm 0.1 \text{ V}$
	$V_{CC} = 1.2 \text{ V}$	
$t_{PHZ}, t_{PZH}$	GND	—



### 11.8. AC Waveform

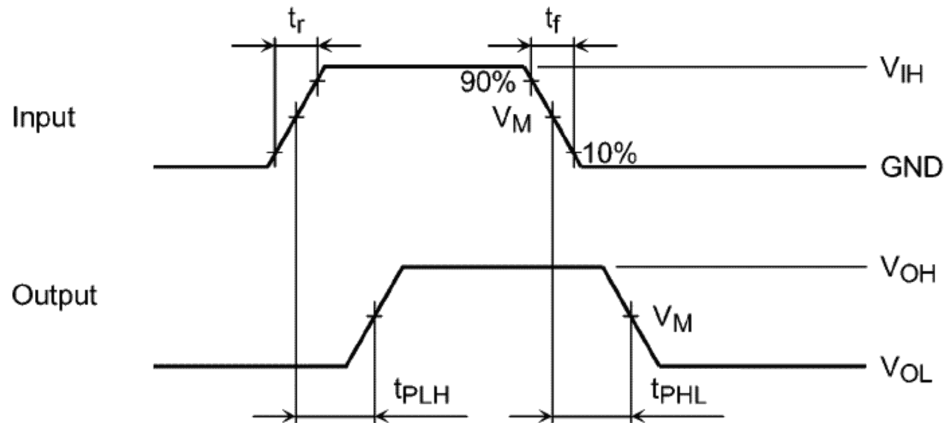


Fig. 11.8.1  $t_{PLH}$ ,  $t_{PHL}$

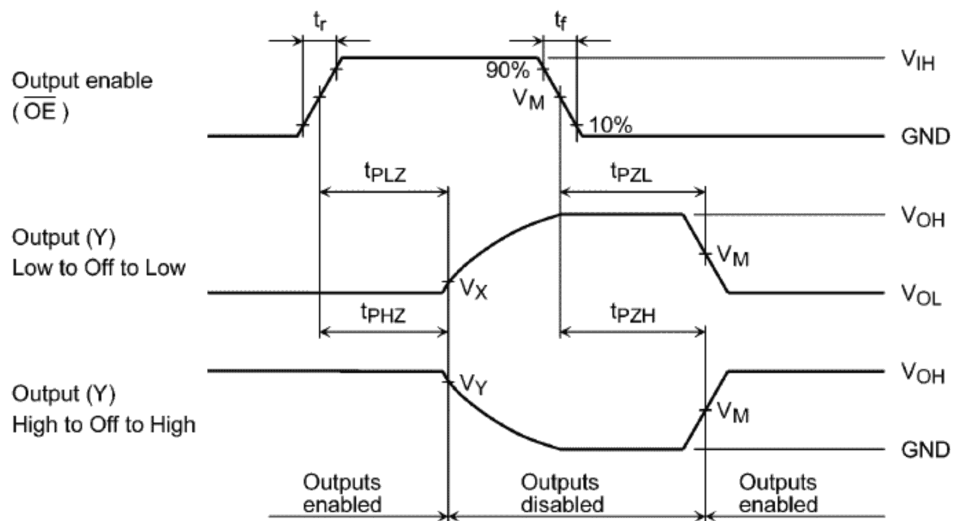


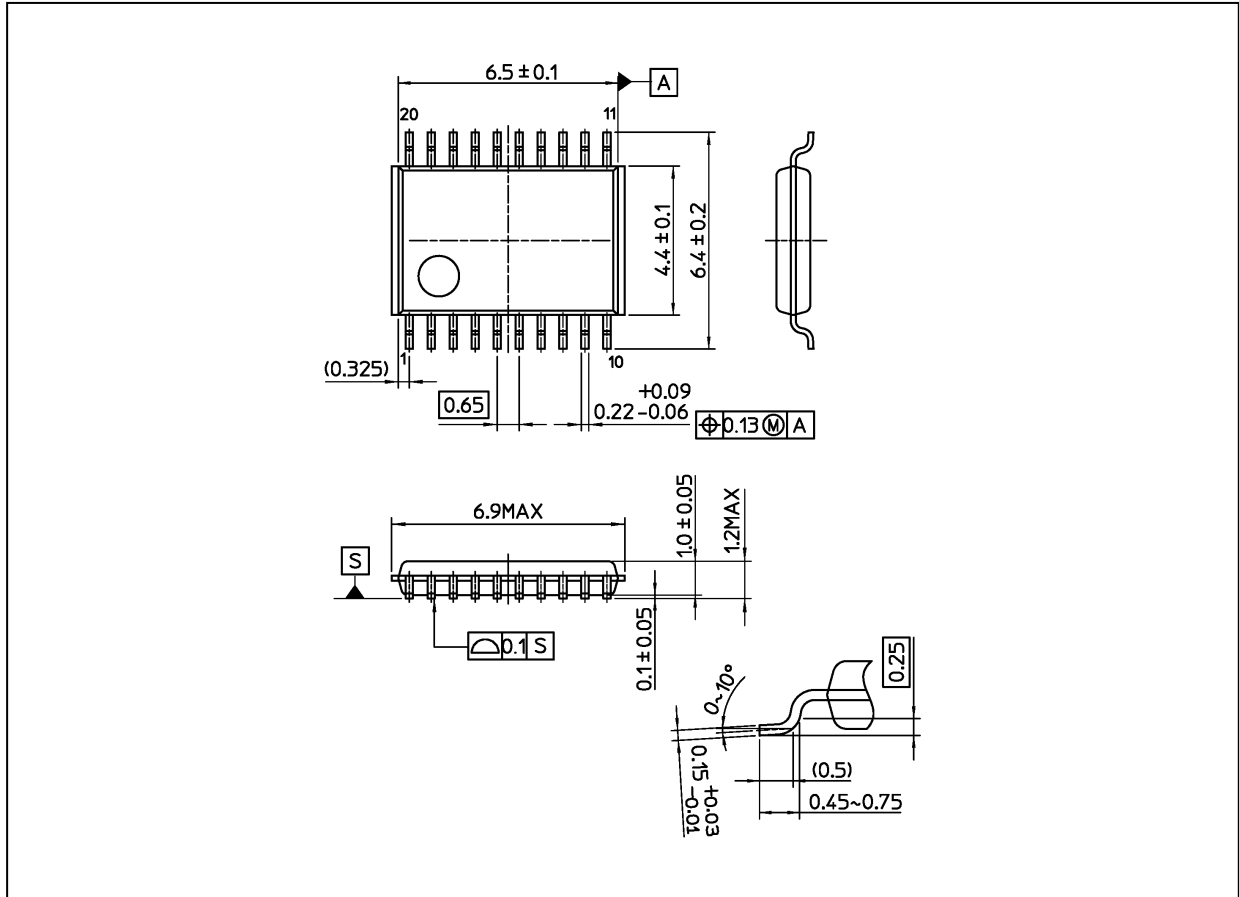
Fig. 11.8.2  $t_{PLZ}$ ,  $t_{PHZ}$ ,  $t_{PZL}$ ,  $t_{PZH}$

Table 11.8.1 AC Waveform Symbols

	Symbol	$V_{CC} = 3.3 \pm 0.3 \text{ V}$	$V_{CC} = 2.5 \pm 0.2 \text{ V}$ $V_{CC} = 1.8 \pm 0.15 \text{ V}$	$V_{CC} = 1.5 \pm 0.1 \text{ V}$ $V_{CC} = 1.2 \text{ V}$
Input	$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
	$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
	$t_r, t_f$	2.0 ns	2.0 ns	2.0 ns
Output	$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
	$V_X$	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
	$V_Y$	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$
Load	$C_L$	30 pF	30 pF	30 pF
	$R_L$	500 $\Omega$	500 $\Omega$	2 k $\Omega$

## Package Dimensions

Unit: mm



Weight: 0.08 g (typ.)

Package Name(s)
Nickname: TSSOP20

## RESTRICTIONS ON PRODUCT USE

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